THE KIWA I.F. FILTER MODULE

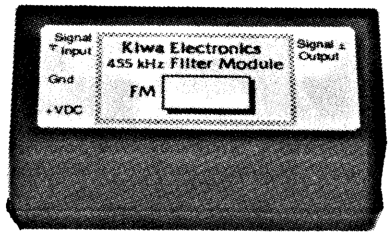
James Goodwin

A complaint many shortwave receiver owners have is the inadequate skirt selectivity in their equipment. This is not just a problem in old or inexpensive units. The skirt selectivity of even some modern, top-priced receivers is less than what it could be for dealing with current crowded band conditions.

Mechanical filters are often expensive, and they may need accompanying resonating capacitors. Sometimes a good drop-in substitute filter can be found; otherwise installation may be difficult. Even with a new filter successfully in place, an insertion loss can result because of impedance mismatch. Such a loss, averaging 6 dB, is not important for strong signals, but for weak ones it makes all the difference in readability.

Now, Kiwa Electronics, well known for its Multiband AM Pickup Unit, has come out with the Filter Module, a product that can provide an inexpensive answer to many skirt selectivity problems. It is ideally suited to be a filter replacement in a solid-state receiver. It also works well in tube receivers. The module, however, can be used only in an intermediate frequency circuit of 455 kHz.

FIGURE 1.
Kiwa Electronics filter module is shown at approximate full size.



THE FILTER MODULE

The main components of the module are three cascaded ceramic filters placed between two buffer amplifiers. The three filters greatly improve the skirt selectivity over what one filter can provide, while the amplifiers offset losses arising from the filters' insertion in the receiver's i.f. circuit.

The filter and amplifier components are embedded in electronic potting compound inside a small, black polystyrene case. Coming out of the unit are two miniature shielded coaxial cables, one marked for i.f signal input and the other for output, plus a black insulated grounding wire and a red insulated wire for amplifier power. The case's dimensions are 0.9 in. (23mm) W. x 1.9 in. (48mm) L. x .75 in. (19mm) H. All the leads are about 12 in. (300mm) long.

Typical bandwidths of the different 455 kHz filter module types are as follows:

Module Type	-6dB BW	-60dB BW
FM 3.5	3.5 kHz	5.8 kHz
FM 4	4.0	6.6
FM 4.5	4.5	7.4
FM 5	5.0	8.2
FM 5.5	5.5	9.1
FM 6	6.0	9.9

A 2.8 kHz (-6dB) filter can be created by cascading two FM 3.5 Modules. An FM 3.5 and an FM 4 similarly placed in series will provide a 3.0 kHz (-6dB) bandwidth. The -60/-6dB shape factor of all is typically 1.8 or less. Wider bandwidths are available upon special request. Ultimate rejection is typically 75dB.

Kiwa offers two special filter modules as replacements for the narrow and broad band filters in the popular Sony ICF-2010/2001D. These have been designed to operate on the relatively lower voltages available in this receiver. The first, the FM 3.5/S, has the same bandwidths as the standard FM 3.5 module; it improves on the selectivity provided by the Sony narrow filter. Guy Atkins has installed this module in his ICF-2010 and he says it works admirably. The broad filter module has a bandwidth of 8 kHz at -6dB, in comparison to the 11 to 12 kHz width of the Sony broad filter. The installation instructions accompanying each module are clear and show the PC board layout.

Returning to the standard module, the voltage requirement for the built-in amplifiers is anything from 4.5 VDC to 36 VDC, although, for "head room", something like a minimum of 9 VDC is preferred. The current for one module runs at about 10 to 12 milliamperes. This power can be taken at a convenient access point in most solid-state receivers without placing any undue strain on the receiver.

Each module comes with a small instruction book, a 10K ohm resistor, cable tie and self-adhesive Velcro for fastening the module in place in the receiver. The instructions understandably have to be limited and general because of the large number of receiver models the module can be placed in. There is a prominent warning about the dangers of high voltages to the module and the installer. Suggestions are given for soldering and desoldering on a printed circuit board. It is explained that the 10K ohm resistor may have to placed in series with the signal input wire if there is apparent distortion resulting from signal overload of the module. To date, only the ICOM R-71 has needed this modification.

Kiwa emphatically warns against installing the module in a tube receiver. The purchaser attempting this assumes the entire responsibility for any consequences. The voltages of 110 VAC and 200 to 300 VDC that are present in the live chassis of a tube receiver can be fatal to the experimenter who is either careless or not knowledgeable about working on such a chassis.

I did proceed on my own in trying out the module in a solid-state receiver and in two hollow-state ones. My description of the first installation is rather brief, largely because it involved only a straightforward filter substitution. This will be the situation with many solid-state receiver installations. On the other hand, there is much more to say about putting the filter module in a tube receiver with its incompatible voltages.

INSTALLATION IN A SOLID-STATE RECEIVER

I installed a filter module in a Kenwood R-1000, a receiver dating from the early 1980's. This receiver has three stock ceramic filters, being, at -6dB/60dB, AM Wide 12/25 kHz, AM Narrow 6/18 kHz and SSB/CW 2.7/5 kHz. Three external push buttons select these, but the owner can make an internal cable switch so that AM Wide selects the 6/18 kHz filter and AM Narrow selects the 2.7/5 kHz. The owner decided to replace the 6/18 kHz filter with a Kiwa FM 4 Module which would give a much improved selectivity of 4/6.6 kHz.

Obviously, anyone working on a receiver needs to have a schematic - important here because the particular filter for removal could not be identified visually, and the input and output points for it on the PC board had to be determined for proper installation of the module. I'd never seen a R-1000 before, but I had the service manual which showed the way with both an electrical schematic and a layout of the PC board.

A 27-watt iron and .10 inch desoldering braid made the removal of the old filter easy. The vacant space left had just the right holes - for signal in, signal out and three grounds. I used a jeweler's loupe with a 2-inch focal length. This was very handy for spotting the last bit of the old retaining solder and for avoiding a solder bridge with the new. However, with a narrow field of vision and the soldering iron tip coming in at 3 o'clock, loss of nose was an ever-present risk.

The module was fastened with the Velcro to the back receiver wall, about 5 inches away from the signal wires solder points, and the power wire was soldered to a nearby 12 VDC i.f. stage supply point. The instructions advise using such a clean power source rather than a possibly noisy one associated with the logic circuitry.

The performance of this filter module has been very satisfying. There has been no signal strength loss. The main benefit has been the much improved skirt selectivity where the previous -60dB bandwidth of 18 kHz has been reduced to 6.6 kHz. The 5 kHz hets from close SW AM signals are gone; splatter from a strong neighbor is either eliminated or greatly reduced. The bandwidth up at -6dB, changed from 6 kHz to 4 kHz, contributes to a good AM audio that is not obtainable from the other narrow filter alternative, the "SSB" filter with 2.7/5 kHz bandwidths.

For the interested experimenter, Kiwa now has available a schematic for a diode-based filter module switch to handle the switching of two modules in a solid-state receiver. The components are few and easily obtained.

INSTALLATION IN A VACUUM-TUBE RECEIVER

When I first read of the filter modules, I thought they might be good as 455 kHz filter additions in two boat-anchor tube receivers I have. These are a 1946 Hallicrafters SX-42, modified, with three dual 455 kHz/10.7 MHz i.f. stages, and a 1951 Hammarlund SP-600J, partially double conversion, also with three 455 kHz i.f. stages. Each has six selectivity positions - three rather wide L/C ones for AM and three crystal ones for CW. The third position in each is the basic "narrow" L/C. Here, the -6/-60dB band widths for the SX-42 are about 4/21 kHz and for the SP-600J about 3/18 kHz - good in their respective times, but most inadequate for today's conditions.

I told Craig Siegenthaler of Kiwa I felt comfortable about assuming the risk and experimenting with these tube receivers. The SX-42 had been the object of repairs and modifications for 36 years while the SP-600 had recently had all its tubular capacitors replaced. Both have features common to many receivers built from the 1930's to the 1960's.

Some obvious questions arose:

1. Where should a filter module be inserted in the circuit?
2. What would be the power source for the amplifiers?
3. Should there be a switch to place the module either in or out of the i.f. circuit? If yes, should the switch be independent of the existing selectivity switch? If yes, what kind of switch?

CHOOSING THE FILTER MODULE PLACEMENT

The 455 kHz i.f. transformer functions are almost identical in the two receivers, but I am showing the relevant section in the SP-600 in Figure 1 as the example because its partial double conversion feature allows a couple of additional filter placement alternatives.

Following the first mixer tube, transformers in T1 develop intermediate frequencies of 3955 kHz and 455 kHz. When the receiver is set to one of bands 4, 5, or 6, i.e. 7 MHz up, switching mechanisms select the 3955 kHz signal as the i.f. at this stage. The signal passes through T2 to the 2nd mixer tube where it and the output from the 3.5 MHz oscillator tube combine to produce a 455 kHz i.f. for input to the primary of T3. Alternatively, if the receiver is set to one of bands 1, 2 or 3, i.e. below 7 MHz, the 455 kHz signal from T1 is selected, and it passes through the gate tube to the input of the T3 primary.

The selectivity switch selects the different band widths (-6dB) - 13, 8, 3, 1.3, .5 and .2 kHz - by varying the circuit configurations in the secondaries of T3, T4 and T5. T3 has one 3 kHz L/C filter in place for all six selectivity positions, but its secondary incorporates a variable crystal filter for the three crystal positions of 1.3, .5 and .2 kHz. T4 and T5 have broadening secondary and tertiary windings to provide the 8 and 13 kHz widths.

Anyone wishing to consider alternative filter insertion points might want to read Dallas Lankford's article in *The Hollow State Newsletter No. 15*. He wrote about the placement of a mechanical filter in the HQ-180(A) and SP-600 receivers which for frequencies of 7 MHz and up both have a higher frequency i.f. stage preceding the 455 kHz one. Dr. Lankford said his concern was to obtain the best broadcast band performance by placing the filter as close as possible to the first mixer. He suggested *A* in Figure 1 as the place of insertion if the user would be satisfied with a filter usable only when the receiver was set at band 1, 2 or 3. For a filter usable on all bands, he recommended point *B*.

WARNING. Filter insertion at *B*, a point of high B+ voltage, would be fatal to a filter unless there are wiring modifications made beforehand. Point *B* is only safe and usable after the B+ line has been routed away from the T3 primary, according to Dallas Lankford's plan, and goes instead directly to the plates of the 2nd mixer and gate tubes. This plate circuit is then connected through a DC voltage blocking capacitor to the filter which in turn is linked to the primary of T3.

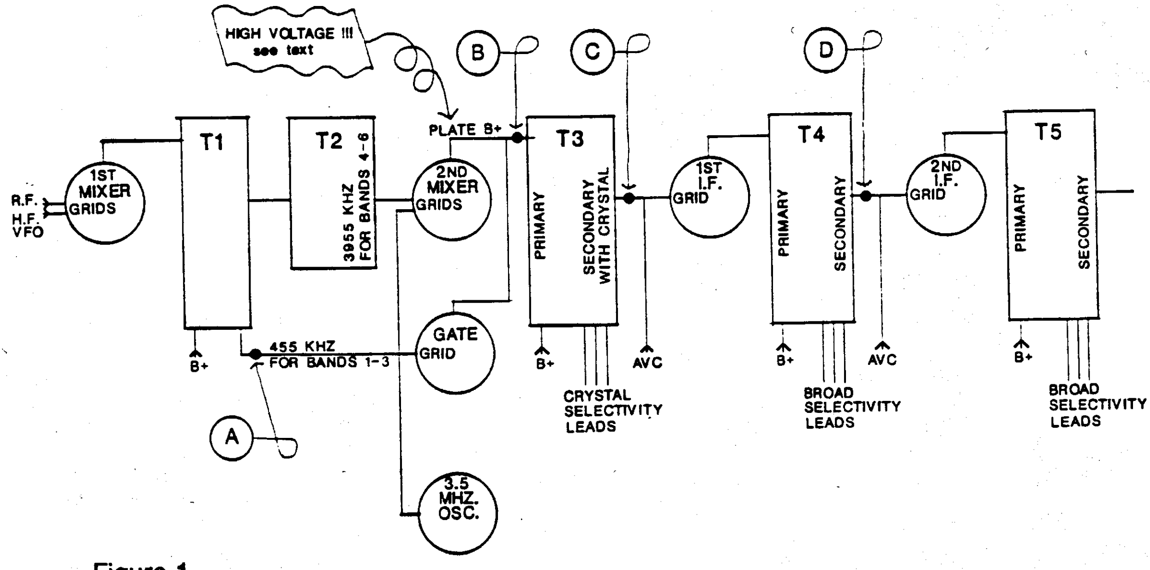


Figure 1
ALTERNATE FILTER ATTACHMENT POINTS FOR HAMMARLUND SP-600

I don't listen to the lower frequencies, and thus had no compelling reason to choose insertion at *A* or *B*. Craig Siegenthaler confirmed that the filter modules include protective blocking capacitors to handle up to 50 VDC. This was fine for my purposes because any installation would likely be only at an i.f. transformer secondary's output where there would be nothing other than a very low r.f. signal voltage and possibly a low AVC voltage.

The first object of experiment was the SX-42. It has one mixer/oscillator, followed by three 455 kHz i.f.'s that correspond in functions to the SP-600's T3, T4 and T5. Each of these i.f. cans also contains, wired in series, a transformer for a 10.7 MHz i.f. that serves for the SX-42's bands 5 and 6 which tune from 27 to 110 MHz. As a person of tube upbringing, I was convinced the powerful pulsations from the 1930's/40's system might well overwhelm the new filter module, in this case an FM 5. For that reason, I inserted the module at the early low-signal-level Point *C*, almost on top of the SX-42's crystal filter. My fears were groundless because the highest generator signals through the module produced no distortion on a scope. And gone were all those irritating 5 kHz hets on the SW broadcast bands.

For a receiver with a crystal filter, a point to consider here is a possible frequency mismatch of the 455 kHz module and the receiver's crystal. Decades ago, there was no point in a manufacturer's buying close-tolerance crystals for consumer-grade receivers. A nominally 455 kHz i.f. strip could be aligned to a crystal frequency of anything between 450 and 460 kHz and work just as well. My SX-42 has a 453 kHz crystal. I could look for a new one, but receiver realignment to 455 kHz now means only that the crystal peaks 2 kHz off center. Used mainly for CW, the crystal circuit, including the phasing control, still performs with just as high a Q. A problem is unlikely to arise in SP-600J/JX receivers with their JAN specifications because the crystal frequency would have to be very close to 455 kHz to permit use of the receiver with ancillary equipment.

I learned subsequently in talking to Craig that he prefers a module insertion after the second i.f. can in order to have a little more prior filter action. So, when I went to the SP-600, a module insertion was made at Point *D*. Again, no distortion and no hets.

POWER SOURCE

I first tried out a module in the SX-42 by powering it with 18 volts from two 9-volt cells. The current was confirmed at 11 milliamperes for one module, and 22 milliamperes for two cascaded. For a permanent source, the required voltage minimum indicated one might rectify and smooth the power from a tube receiver's 6.3 VAC filament supply. However, Craig thought a voltage more dependably higher than the minimum could be obtained at little cost by access to the receiver's B+ supply through dropping resistors and a regulating Zener diode. His suggested power circuit is included in Figure 2.

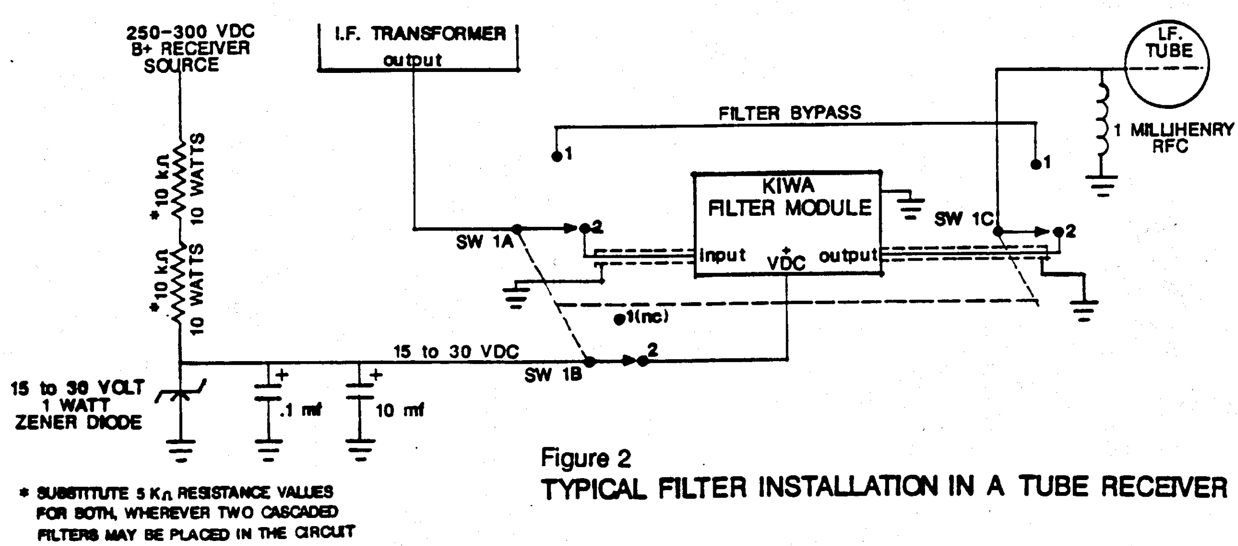


Figure 2
TYPICAL FILTER INSTALLATION IN A TUBE RECEIVER

If there will be no more than one filter in the circuit at a time, a dropping resistance of 20K ohms, 10 watts, is satisfactory. For this, two 10K ohm resistors in series are preferable for better heat dissipation. In my case, where two cascaded filters would be in the circuit from time to time, the dropping resistance was halved, i.e. the resistors are two of 5K ohms because of the doubled 22 ma. draw. The one-watt 24-volt Zener diode holds the final voltage at 24, whether either one or two modules are drawing power. Although the filter module power requirement is low, the extent of the voltage drop required in tube receivers with this method means that most of the power consumed is wasted in heat.

A cooler but slightly more expensive power alternative for a tube receiver would be a small independent 110 VAC transformer. This would put out a low AC voltage which a bridge rectifier, smoothing capacitors and voltage regulator would convert to low DC. This alternative may be desirable where the receiver's power supply is already either running very hot or running an output current in excess of its design level.

SELECTIVITY SWITCHING

In some circumstances, a user may be satisfied with having an unswitchable in-circuit filter module in the i.f. However, where a receiver has provided a number of bandwidth choices, albeit wide ones, I like to maintain that choice. The fixed-filter option in any event was not possible in the SX-42 because the 10.7 MHz i.f. signal used on the 27-110 MHz bands passes through the same i.f. line used for the 455 kHz signal on lower frequencies. The module was going to have to be switched in and out. Although 455 kHz is considered to be near the upper limit for effective i.f. mechanical switching, it seemed right to go that old way because I had the parts for a three-wafer six-position rotary switch (successively made under the Centralab and CRL labels). Spaced rotary switch wafers afford a little more separation of input and output signals than do other types of unshielded mechanical switches. Since I did this work, Kiwa has come out with the previously mentioned diode-switch schematic. Some tube receiver experimenters may want to consider adapting this alternative.

Figure 2 shows the simple in/out filter switch arrangement I used. In fact, I have ended up with three module switch positions because I put in a 5 kHz, 4 kHz and a 2.8 kHz module (i.e. 2 x 3.5 kHz cascaded). RG-174 coax was used for the lines from the switch to the i.f. transformer and tube respectively because the runs were each about 8 inches and passed close to earlier circuit stages. This meant there were many shields and ground wires to ground to the chassis at one central point. The new coax cable attachments added a capacitance to the 455 kHz secondary preceding the filter and caused some detuning. A small core adjustment brought it back to normal. However, in a situation unique to the SX-42, the associated 10.7 MHz secondary with its small 45 pf. capacitor was detuned far more and will require a very low-value capacitor substitution to restore alignment.

I was concerned about degraded filter action because of signal leak-through at the switch. The two spaces between the three wafers are each about .5 inches, with the middle wafer being chosen as the power on/off switch. Craig Siegenthaler thought that the resultant one-inch space between the in and out signal wafer switches would be quite adequate. I'd allowed for putting in a shield, but, from subsequent performance, this doesn't seem necessary.

As for the SP-600, it has temporarily in its chassis side a single-wafer three-pole rotary switch. I want to retain the old wide bandwidths in the SP-600; without them, it wouldn't be the same receiver. One possibility is to remove the send/receive switch and in its place run a switch shaft extension back to a 1" diameter 3-section wafer switch at the second i.f. stage filter insertion point. This "two selectivity switches" set-up would emulate that in the SX-42. On the other hand, the SP-600, like many other receivers, has a relatively simple selectivity switch wiring arrangement. The more ambitious experimenter could combine in one new switches-and-shaft set the control of both the original system and a filter module or modules.

A matter comes up for consideration if one is putting in either an unswitchable filter module or a single combining selectivity switch. In either case, a filter module will be linked permanently with a receiver L/C filter. This latter filter should be the one that will best preserve the module's filtering action without allowing through avoidable broadband i.f. noise. We can take the example of the SP-600 with its three L/C filters - the "3", the "8" and the "13." For a signal to pass through with the Kiwa's desirable trapezoidal response shape, that shape should come as close as possible to fitting within the more pyramidal response shape of the SP-600 L/C filter. This arrangement is the same as the existing system in the SP-600 where the crystal filter, when in use, passes a signal through the 3 kHz L/C filter, the narrowest one available.

The FM 5 module for example, with its 5.0/8.2 kHz widths, could not be matched well with the "3" with its 3.0/18 kHz widths because the 3 kHz width at -6dB would cut off the "top corners" of a module-shaped signal passing through, thus altering the shape to one derived from the two filters. In theory at least, the resultant hybrid bandwidths would be 3.0/8.2 kHz. On the other hand, the FM 5 could not be matched with the "13" because the latter is excessively wide - 13/35 kHz - and does allow through perceptibly too much broadband i.f. noise. The "8" therefore with its 8/26 kHz widths is left as the best match for a FM 5.

INSERTION LOSS OFFSET

The module amplifiers do balance off any signal loss quite well. In the SX-42, the filter-on status adds one or two dB to signal strength in comparison with filter bypass. The opposite is true in the SP-600. The variations in either case are no more than those that exist among the receivers' L/C filters. It surprised me that the modules, even two cascaded ones taken as one, are absolutely equal to each other from the point of view of resultant signal strength.

CONCLUSION

I have had excellent results with the modules. They are just what was needed to take care of common skirt-selectivity problems. In addition, Craig Siegenthaler has given me every assistance, just as he does, I'm sure, all Kiwa's customers.

A Filter Module costs $40.00, plus $4.00 shipping, and is available from Kiwa Electronics, 612 South 14th Avenue, Yakima, WA 98902. (509) 453-KIWA.

REFERENCE:

Lankford, Dallas, "Collins Disc-Wire Mechanical Filters, Part 3," *The Hollow State Newsletter No. 15,* Fall 1986. Earlier parts appeared in issues 11 and 12. *The Hollow State Newsletter* is published by Ralph Sanserino, 11300 Magnolia #43, Riverside, CA 92505. Back issues available for $1.25 each.

EDITORS' NOTE:

Just before press time, we received notification from Craig Seigenthaler, the creative force behind Kiwa, that they were now offering a PC board unit to hold and control two filter modules. We asked author James Goodwin's permission to append this note, so that you could be made aware of this most welcome new product.

The new unit, called FMX, contains the loaded PC board plus a toggle switch and appropriate metalized polyester labels. The FMX unit, loaded with two FM filter modules measures 2.7" x 3.8" x .75". That is small enough to fit in an out-of-the-way place in most table top receivers. In a modern solid state receiver, one would connect the module to any open filter position. Choice between the two Kiwa filter modules would then be controlled by the toggle switch which would be mounted conveniently on the receiver. Along with the photo which follows, Craig sent several others showing a FMX unit with two filter modules aboard fitting nicely to the under side of the chassis of a ICOM R-71A.

The new FMX unit is priced at $36.00 from Kiwa. Therefore, an FMX board plus two FM filter modules of your choice would total $116 + $5.00 shipping (U.S.) See above for Kiwa's address. Of course, the filter modules continue to be available singly, as well.

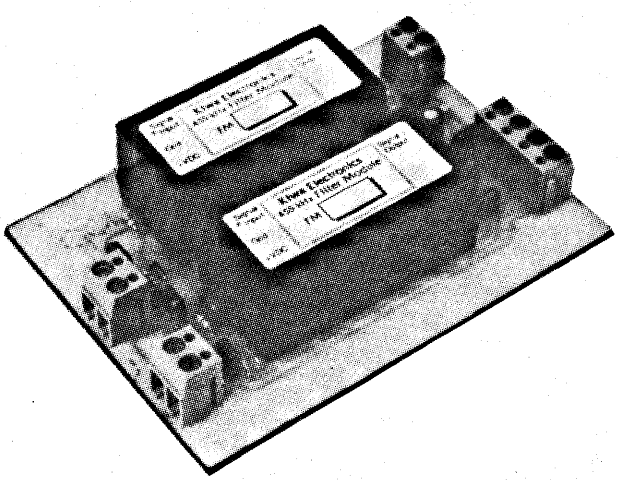


FIGURE 2. The new Kiwa FMX unit is shown loaded with two FM filter module units. Note the solderless screw terminals.